

IMMUNOLOGY

FOR MEDICAL STUDENTS

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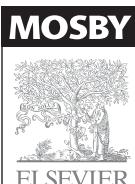
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PREFACE

■ PREFACE TO THE SECOND EDITION

In preparing this edition, we have made improvements throughout to improve the clarity and accessibility of the material. We have updated all the sections, particularly the material dealing with Toll-like receptors, dendritic cells, regulatory T cells, and HIV. We have also introduced a final chapter on therapeutic immunomodulation, which is being increasingly utilized in clinical practice. This chapter also aims to review what readers will have learned about the immunopathogenesis of several diseases covered in earlier chapters. In response to user feedback, we have also enhanced the clinical vignettes, which form the final pages of most chapters. Although some of these vignettes describe rare diseases, we hope that this helps readers link their studies of immunology with real clinical experience.

■ PREFACE TO THE FIRST EDITION

We have recognized the need for an immunology book that is primarily focused on the needs of medical students for as long as we have been teachers of immunology. This book has been written to fill this need. Immunology can fall into different medical school courses or modules. Often, the immunology is taught in the Host Defense course, which integrates basic and clinical immunology (including allergy, immunopathology, etc.). Some medical schools, however, teach basic immunology and clinical immunology in two separate courses. This book should be useful for either curriculum organization.

We have concentrated on a simple, straightforward treatment of the subject. The book is relatively short and contains the topics we considered important to understand the human immune system and its role in protecting us from disease. This reflects our acknowledgment of the time constraints on today's medical student. With new topics and a growing amount of information considered to be essential, there are increasing demands on students. It is therefore important to have a concise, readable textbook, and that has been our primary aim. Most chapters contain the information needed for a typical 50-minute large class or small-group teaching/learning session. This, of course,

means that details dear to the hearts of some immunologists are not covered!!

We are aware of two specific problems that medical students have with immunology. First, the immune system is complex, because it has evolved to respond to the wide range of pathogens. Many students find themselves bogged down in the complexities of the molecules and cells of the immune system, without having an understanding of how these components work together to fight infection. We begin our book with two overview chapters that explain what the immune system does and then how the components fit together. We recommend that students begin by reading these chapters. Further on in the text, there are more short, integrating overview chapters. These are not just for revision, but are there to make sure that the student understands how the material that they have read fits into the overall system. The second problem is that medical students do not always immediately see the relevance of immunology to day-to-day clinical practice. We have included clinical correlations throughout the text, which explain how understanding the science of immunology can translate into understanding real clinical problems.

The book is a concise description of the science of immunology, a topic that defies a final complete description, because there is much still to be learned. Hopefully, we will have succeeded in inducing an interest and appreciation of the relevance of immunology to medical students, to form the basis for a lifetime of learning about the immune system and its potential for use in improving the human condition. Most medical students today could still be practicing medicine in 40 to 50 years. Approximately 50 years ago, immunology was still in its infancy. For example, we did not know the chemical structure of antibody molecules in any detail, and treatments such as organ transplantation had not been carried out. The next 50 years will likely bring equally important advances in the field. History suggests that we would be foolish to try to predict what they will be. We hope that you enjoy participating in these advances in immunology and their application to human disease as much as we have in those that we have been privileged to observe in our careers.

2002

R.N. & M.H.

ACKNOWLEDGMENTS

Once again I am indebted to my wife, Morag, for her help in preparing my chapters for this book. This edition is dedicated to my family and to all the medical students I have had the opportunity to teach and learn from.

R.N.

My colleagues' generosity has kept me abreast of a rapidly changing subject and provided me with invaluable material for publication. I would not have been able to write this book without the support and patience of my family, to whom I am indebted.

M.H.

HOW TO USE THIS BOOK

Immunology for Medical Students is organized to be read comprehensively. The flow of the book is from genes and molecules to cells and organs, and finally to the immune system as an integrated system protecting the body from infection and helping to maintain the health of the body.

Section 1 introduces the basic concepts and is essential for an understanding of the language of immunology.

Section 2 continues with a discussion of the antigen-recognition molecules, that is, antibodies, T-cell receptors, and the molecules encoded by the major histocompatibility complex.

Section 3 deals with immune physiology, the role of the cells and organs of the immune system in the response to a pathogen.

Section 4 discusses the innate immune system and its connections to the adaptive immune system.

Section 5 considers hypersensitivity, allergy/asthma, autoimmunity, immunodeficiency, transplantation, among others, and includes a new chapter on therapeutic immunomodulation.

Throughout the book, the core knowledge objectives are listed as Learning Points at the ends of chapters to aid in review. There are also several integrating overview chapters (e.g., Review of antigen recognition, Review of immune physiology), and these focus the student on the major points. Each section is relatively freestanding. For example, Section 5, Immune System in Health and Disease, could be used in a clinical correlations course, independent of the remainder of the book. *Immunology for Medical Students* will be most useful in the comprehensive Host Defense-type courses that are growing in popularity in medical schools.

The icons used throughout are illustrated overleaf. You should become familiar with them immediately to follow the illustrations. We have selected several pathogens (listed in the figure overleaf) to use throughout the book as examples. As a reminder, some basic aspects of the structure and mechanism of action of these organisms are described. You should re-acquaint yourself with these organisms, undoubtedly encountered in microbiology or infectious disease courses, and use the figure as a convenient reference as you encounter these pathogens in the examples in this book.

In general, boxes have been clustered at the end of chapters in the second edition to aid in the flow of the text and in understanding of the material.

CLINICAL BOX

Clinical boxes, throughout the text, put immunology into a clinical context. The clinical material selected is current and relevant.

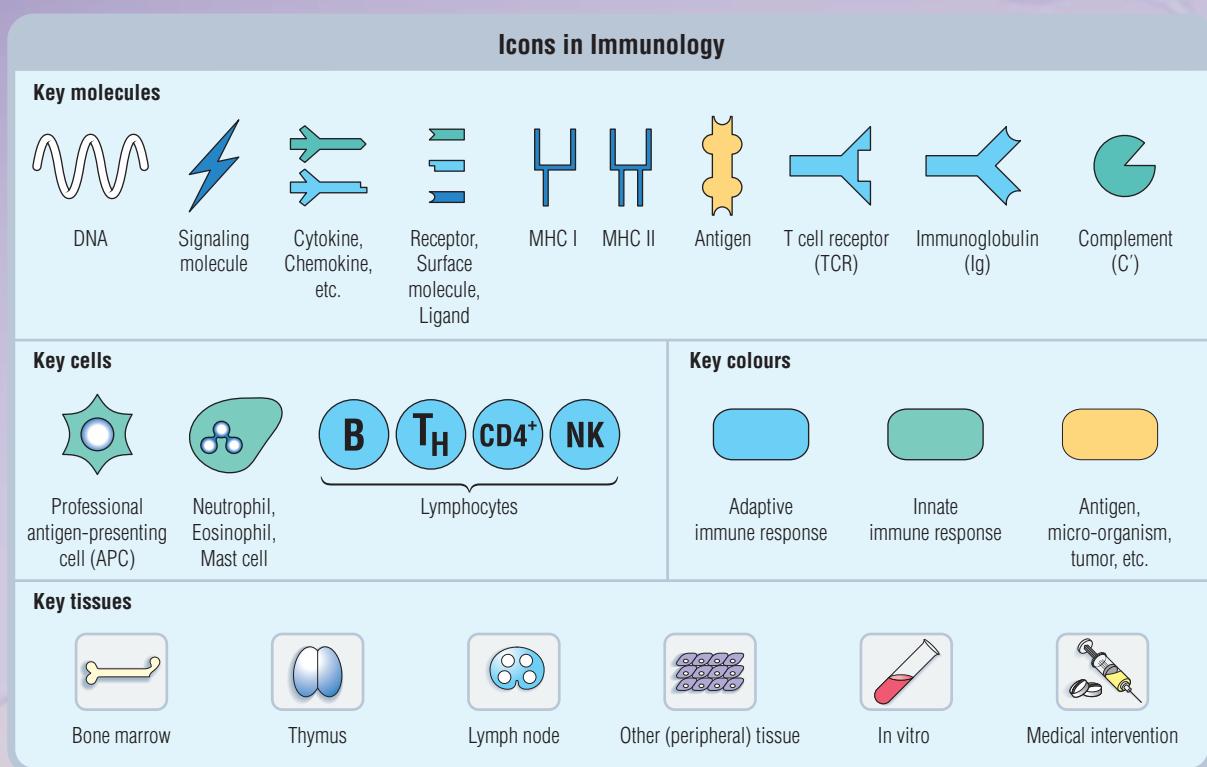


TECHNICAL BOX

Technical boxes show how advances in the field have expanded our knowledge of how the immune system works, and provided new means of preventing disease.



ICONS



This figure shows some of the different types of infection the immune system has to cope with. The mechanisms used by the immune system in response to each of these infections is described in detail in different chapters of this book.

Pathogen	Type of Organism	
Human immunodeficiency virus (HIV)	RNA virus	HIV infection requires intimate sexual contact or exposure to blood. HIV has a small genome that frequently mutates, allowing escape from the immune response. Most infected individuals do not develop adequate immunity to clear the virus. Infection frequently results in AIDS. No vaccine exists.
Influenza virus	RNA virus	Influenza causes global epidemics. Casual contact can result in infection of the respiratory tract, causing influenza. Influenza is also a small virus, and annual epidemics reflect the emergence of mutant strains that are not recognized by the populations' immune system. Vaccines exist, but have to be changed every year to overcome mutations. A new avian influenza virus has recently emerged, which would cause a large-scale epidemic if it exchanged genes with the human virus and acquired the ability to easily infect humans.
Epstein-Barr virus (EBV)	DNA virus	EBV infects the pharynx causing glandular fever or "infectious mononucleosis." B lymphocytes of the immune system are also infected, and their uncontrolled growth can sometimes lead to lymphoma (a type of malignancy). EBV has a large genome that does not mutate frequently. The genome encodes proteins that help EBV evade the immune system.
Hepatitis B virus (HBV)	DNA virus	HBV infects liver cells. In many individuals, there is only transient liver damage. In others, there is chronic, severe liver damage, possibly as a result of the immune response to HBV.
<i>Bordetella pertussis</i>	Bacterium	<i>B. pertussis</i> infects the airways and causes whooping cough, which can be life-threatening. A very effective vaccine exists, and whooping cough has become rare in the developed world.
<i>Escherichia coli</i>	Bacterium	<i>E. coli</i> is a normally harmless bacterium living in the colon. If it enters the bloodstream in small numbers, phagocytes usually destroy such bacteria. When <i>E. coli</i> survives in the bloodstream, septic shock may occur.
<i>Mycobacterium tuberculosis</i>	Bacterium	<i>M. tuberculosis</i> also infects the airways. It is able to survive inside phagocytes. Because of this intracellular site, it is difficult for the immune system to clear infection, and tuberculosis may result. Tuberculosis is a major threat to global health, in part because patients with AIDS are particularly unable to clear mycobacterial infection.
Schistosoma	Helminth	This worm invades the gut and urinary tract. A special part of the immune system, involving mast cells, has a role in eradicating such infections.

CONTENTS

SECTION I Introduction

1. Introduction to the Immune System
2. Basic Concepts and Components of the Immune System
 - Innate immunity, 7*
 - Adaptive immunity, 8*
 - Components of the immune system, 9*
 - Active and passive immunity, 11*
 - Phases of an immune response, 12*

SECTION 2 Antigen-Recognition Molecules

3. Introduction to Antigen Recognition
 - Antigen-recognition molecules, 16*
4. Antigens and Antibody Structure
 - Antigens, 19*
 - Antibodies, 20*
5. Antibody–Antigen Interaction
 - The antigen-binding site of antibodies, 26*
 - Diagnostic tests for antibody or antigen, 27*
6. Antibody Diversity
 - Immunoglobulin genes, 34*
 - Immunoglobulin classes, 38*
 - Allelic exclusion, 40*
7. The T-cell Receptor
 - Biochemical characterization and relationship to immunoglobulin, 44*
 - Generation of diversity of the T-cell-receptor genes, 45*
 - Recognition of Antigen, 46*
 - Other accessory molecules involved in T-cell function, 46*
8. Major Histocompatibility Complex
 - Genetic organization, 50*
 - Regulation of gene expression, 50*
 - Structure of the major histocompatibility complex gene products, 51*
 - Restriction of antigen recognition, 53*
 - Population advantages of polymorphism in the major histocompatibility complex (“heterozygote advantage”), 56*
 - Disease correlations, 56*
9. Review of Antigen Recognition
 - Important structural features, 58*
 - Generation of diversity, 60*

SECTION 3 Physiology

2. 10. Antigen Processing and Presentation
 - Pathways of antigen processing, 62*
 - Mechanisms of antigen processing, 63*
 - Evasion of processing pathways by pathogens, 66*
7. 11. Lymphocyte Activation
 - Antigen receptors, 69*
 - Signaling events, 71*
 - Amplification through signaling pathways, 73*
 - Response, 74*
16. 12. Hematopoiesis
 - The three major stages of hematopoiesis, 78*
 - Lymphoid cells, 78*
 - Myeloid cells, 80*
19. 13. The Organs and Tissues of the Immune System
 - Primary and secondary lymphoid organs, 84*
 - Lymphocyte recirculation trafficking and homing, 89*
26. 14. B-Cell Development
 - Early B lymphocyte development, 96*
 - The transition from immature to mature B cell, 98*
 - The mature B cell, 102*
 - Continued selection of B cells in lymphoid follicles, 103*
 - Thyus-independent antigens, 104*
 - The B-cell repertoire and human development, 104*
34. 15. T-Cell Development
 - The thymus, 108*
 - The periphery: naive T-cell activation by antigen, 112*
44. 16. Cell–Cell Interaction in Generating Effector Lymphocytes
 - Generation of stimulated (or primed) B and T cells, 120*
 - Generation of effector cells, 121*
 - Providing the most appropriate immune response for a given pathogen, 123*
50. 17. Immunologic Memory
 - Long-term immunologic memory, 129*
 - Lymphocyte homeostasis, 131*
 - Apoptosis, 133*
58. 18. A Brief Review of Immune Physiology
 - The integrated immune system: connections between the adaptive and innate responses, 136*

CONTENTS

SECTION 4 Innate Immunity

19. Constitutive Defenses Including Complement
Barriers to infection, 140
Extracellular molecules of the innate immune system, 141

20. Phagocytes
Phagocytic cell types, 151
Phagocyte production, 152
Phagocyte recruitment, 152
Receptors on phagocytes, 153
Actions of phagocytes, 155
Phagocyte defects, 157
Molecular recognition by the innate and adaptive immune systems, 157

21. Killing in the Immune System
Response to parasite worms, 161
Mast cells, 161
Natural killer cells, 164
Intracellular mechanisms of apoptosis, 167

22. Inflammation
Types of inflammation, 171
Cytokine network in inflammation, 172
"Overzealous" inflammation, 173

23. Cytokines in the Immune System
Introduction, 180
Definitions and some general notes about cytokines, 180
Cytokine receptors and signaling molecules, 181
A review of some of the roles of cytokines in immune responses, 183

SECTION 5 Immune System in Health and Disease

24. Infections and Vaccines
How organisms evade the immune response, 188
Mechanisms of immunity, 188
Types of vaccine, 189
Vaccine schedules, 191

25. Hypersensitivity Reactions
Types of triggers for hypersensitivity, 196
Types of hypersensitivity reaction, 197
Diagnosis and treatment of hypersensitivity, 198

26. Immediate Hypersensitivity (Type I): Allergy 202

Definitions, 202
Allergen, 202
Degranulating cells, 203
Antibody, 203
T_H2 cells, 203
Predisposition to allergy, 204
Mediators of early phase, 206
Mediators of late phase, 206
Treatment, 207

27. How Autoimmune Disease Develops 214
Some autoimmunity is normal, 214
The initiation of autoimmune disease, 215
A reminder about T-cell tolerance, 216
The breakdown of T-cell tolerance, 217
Tests for autoimmune disease, 218

28. Antibody-Mediated Hypersensitivity (Type II) 227
Immune-mediated hemolysis, 227
Type II hypersensitivity and antibodies that affect cell function, 230

29. Immune Complex Disease (Type III Hypersensitivity) 236
Antigens in immune complexes, 236
Antibodies in immune complexes, 237
Clearance of immune complexes, 237
Mechanisms of inflammation in immune complex disease, 238
Immune complex disease in the kidney, 239
Treatment of immune complex disease, 240

30. Delayed Hypersensitivity (Type IV) 244
Delayed hypersensitivity reactions are driven by T_H1 cells, 244
Type IV hypersensitivity disease, 244
Some hypersensitivity reactions are driven by mixed mechanisms, 248

31. Primary Immunodeficiency 252
Significance of immunodeficiency, 252
Infections provide clues to the type of immunodeficiency, 252
Causes of primary immunodeficiency, 253
Diagnosis, 254
Treatment, 255

32. Secondary Immunodeficiency 260
HIV infection, 260
Other secondary immunodeficiencies, 265

CONTENTS

33. Transplantation	269	35. Monoclonal Antibodies and Recombinant Cytokines	288
<i>Transplantation terminology, 269</i>		<i>Monoclonal antibodies, 288</i>	
<i>Solid organ transplantation, 269</i>		<i>Recombinant cytokines, 292</i>	
<i>Stem cell transplant, 271</i>			
<i>Tissue-typing techniques, 272</i>			
<i>Immunosuppressive drugs, 273</i>			
<i>Xenotransplantation, 273</i>			
34. Tumor Immunology	279	36. Review of Immunity in Health and Disease	294
<i>Lymphoid tumors, 279</i>		Glossary	297
<i>Immunity to tumors, 282</i>		Index	301